Stereoscope Training Guide

Pacific Region

"Proficiency through practice"

AUGUST 1952

Revised April 1954

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE PACIFIC REGION

AGR-SCS-PORTLAND, ORE. AUGUST, 1952

C O N T E N T S

AGR-SCS-PORTLAND ORE APR. 1954

FOREWORD

Very few of us really know how to use a stereoscope effectively in making a soil survey. This is a surprising situation, in view of our conviction that many of our activities can be speeded up materially as well as being conducted with greater accuracy, through the stereoscopic approach.

It is hoped that you will study this guide carefully, improve your own understanding of stereoscopy, and thereby incorporate in your own work the important advantages of this now inadequately-used procedure.

INTRODUCTORY PRINCIPLES

If you look at any object with both eyes, you get a three-dimensional view. You see it in terms of width, height and depth. Because each of your two eyes focus on an object from a different position, each eye transmits a different image to your brain. There, the two transmitted images are combined into a single three-dimensional counterpart of the original object. However, if you close one eye and look at the object with the other, you can have no more than a two-dimensional image. Depth, or the distance factor, is lost for all practical purposes, and distance can only be judged by the apparent size, or the relative position of familiar objects.

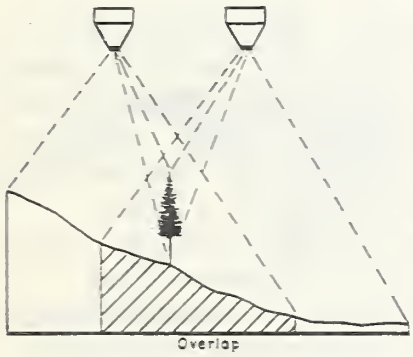


Fig. 1.

The aerial photographs used in soil surveys are taken in a series of exposures at regular intervals along a line of flight. If you look at only one photograph, it is like viewing the scene with one eye. The interval between exposures is so timed that we get about 60 percent overlap in coverage. (Fig. 1)

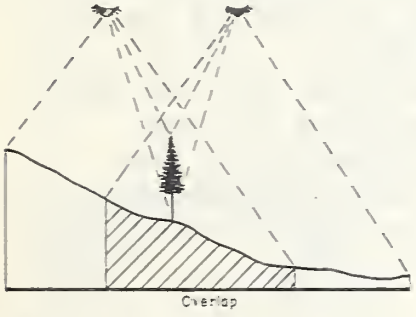
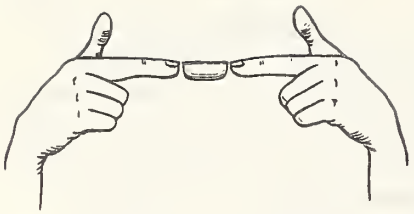


Fig. 2.

This provides two photo images of the same land area, each from a different camera position. The two camera positions are comparable to the relative positions of your eyes. (Fig. 2) When you view the two photographs under a stereoscope, you get a three-dimensional representation of the land surface.

Adjacent photos in side by side flight lines may also be viewed stereoscopically; however, the three-dimensional area is usually small because sidelap or side-overlap is only 30 percent or less as compared to the 50 to 60 percent overlap of the stereopair in line of flight.



Anyone with normal eyesight (or even with defective vision, if corrective measures are taken) can really see the third dimension when he uses a stereoscope correctly. To test your own ability to see stereoscopically, look intently at a small object about 20 feet away and on a level with your eyes. Then extend the forefinger of each hand, raise them to eye level and without changing the focus of your eyes on the distant object, slowly bring your fingertips together on the line of sight. If you see an "ocular weinerwurst" between your fingertips, you can learn to use a stereoscope successfully.

KINDS OF STEREOSCOPES

There are several kinds of stereoscopes, the principal difference between them being in the optical method used to diverge the lines of sight. The three principle types are: prism stereoscopes, lens stereoscopes, and reflecting or mirror stereoscopes. Some reflecting stereoscopes are equipped with binoculars to greatly magnify the image. This attachment is considered unsatisfactory for most soil survey work, as it drastically reduces the field of vision. It is especially valuable, however, in the identification of survey stations and other minute detail.

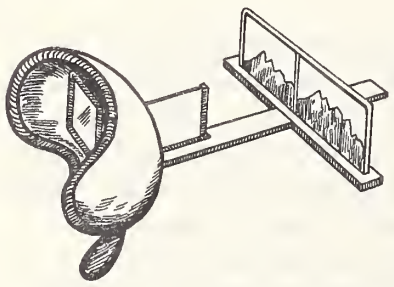


Fig. 3.

Probably the best known and most common example of a prism stereoscope is the old fashioned parlor stereoscope. (Fig. 3) In it, the lines of sight are spread by means of thin, wedge-shaped prisms. It has slight magnification, the field of vision is limited, and the focal distance is quite critical.

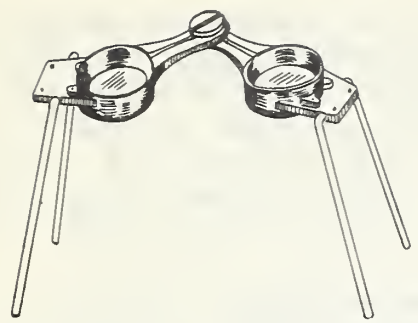


Fig. 4.

An example of a lens stereoscope is illustrated in Fig. 4. This is a pocket-size stereoscope which has been issued to most survey personnel. It is effective because the lens extends the focal length of the eyes, thereby overcoming normal convergence. It has a magnification power of a little over two times. The photographs are placed at a distance from the lens which is equal to its focal length. As this is much like placing the photos at or near optical infinity of one's eye, the lines of sight are nearly parallel. Most lens stereoscopes are relatively inexpensive and convenient for field use. They can be used effectively with contact prints (7"x9" or 9"x9") and 4" - mile enlargements.

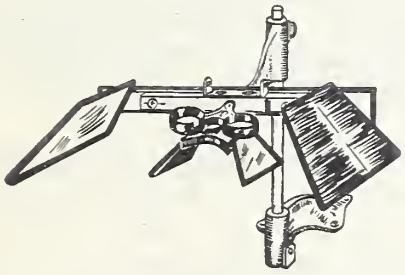


Fig. 5.

A reflecting stereoscope (Fig. 5) spreads the line of sight by prisms or mirrors. The lens-mirror assembly can usually be raised or lowered until the photo image is in sharp focus. Commonly, lines of sight at the point of focus are separated a distance of about 9 inches. This enables the user to examine a much larger picture area without moving the photographs, than is possible with a lens stereoscope. Reflecting stereoscopes can be used to view contact prints or enlargements. For 8" - mile enlargements, special devices such as those described on page 13 will be found helpful.

INITIAL SELF-TRAINING

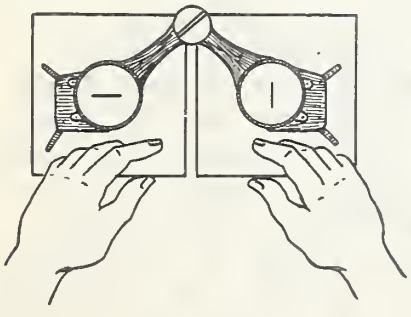
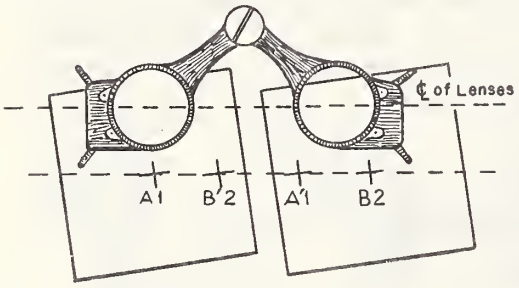


Fig. 6.

You will need to learn the art of eye control. One of the simpler methods for making your eyes behave is to take two blank sheets of paper, draw a horizontal line on one and a vertical line on the other. Place one sheet below the right-hand lens of your stereoscope and the other below the left-hand lens (Fig. 6). Now, look directly through the eye pieces with each eye focused on only one of the

sheets. Then hold the left-hand one in place and move the right-hand sheet slowly to the left or right, until the horizontal and vertical lines appear in the form of a cross. It is helpful if you blink your eyes alternately while bringing the two images into focus. A piece of cardboard placed perpendicularly between the lenses may help in training each eye to focus separately on its subject. The exercise may tire your eye muscles at first, but it will do them no harm. It is like exercising any other muscles beyond their usual degree of use. After the cross appears, the left-hand sheet should be moved until the image again separates into vertical and horizontal lines. Then shift the sheets until the lines once more join in a cross. These two steps should alternate until "fusing" is done rapidly. With the cross fused, note the approximate location of each sheet with reference to the lens or mirror of your stereoscope. Then remove the sheets and replace them to train your eyes to focus on the lines and fuse them rapidly into the cross. When this can be performed quickly and accurately, you are ready to begin stereoscope training with aerial photographs. Remember, identical points of detail on the two separated photographs will be approximately 2 inches apart under the pocket stereoscope and approximately 9 inches apart under the mirror stereoscope.

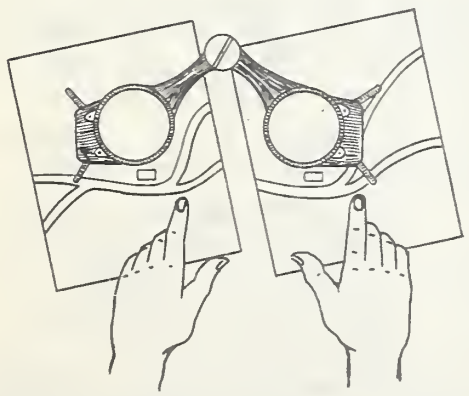


To start with aerial photographs, you should select a stereopair showing land with moderate relief and a distinct pattern of surface features. They should be of equal tone and identical scale. First, mark the optical center of each photograph with a small cross (A1 and B2). (These centers are located at the intersection of lines drawn between the small ticks or fiducial marks, located at mid-point along each photo margin). Next transfer the optical center of each photograph to the other (A'1 and B'2) and connect the two crosses on each photograph with a straight line. This line represents the flight line of the photographic aircraft. The line may intersect the photo edge at a slight angle from the perpendicular due to the "crab" or "drift" of the aircraft in flight. Now, place this pair of photographs under the stereoscope so that the center to center

line on one photograph is a continuation of that on the other and overlapped so that the center of one photo and its transferred location on the other photo are separated by about 2 inches. Lastly, it is essential that these lines also be parallel with an imaginary line drawn through the centers of the stereoscope lenses. Now relax your eyes and look through the stereoscope.

If you really are a beginner in the use of a stereoscope, it might be advantageous at this stage to make use of some of the training devices which are available. For example: one of the more difficult, and most important steps, is to place your two photographs in proper position relative to one another and to the stereoscope. Even a slight twist from parallel will obscure your third dimension values, creating distortion and eye strain. Stereoscopic slides, view boxes and a stereo-projector are available from the Regional Office on request. The stereo plates carried in an envelope at the end of this guide, as well as the slides, have already been matched and positioned. By studying them, you should gain a good understanding of what to expect from your own photographs, if you handle them correctly.

The photographs should be moved toward, or away from, one another until the crosses and connecting lines are fused under the stereoscope. As soon as this occurs, one of the photographs should be shifted until fusion is lost, and by further movement again recovered. To advance your training, continue to practice this until many of the more prominent features on the photographs can also be fused rapidly. As skill develops, you will begin to fuse the images more by observing these physical features than by matching the crosses and lines.



After you have gained some skill through these exercises, you should begin using photographs <u>without</u> the crosses and lines. Take two such pictures and place them under a stereoscope with the index finger of each hand at some prominent feature (road intersection, lone tree, or building) which appears on both photographs. Shift the pictures until your two fingers coincide. Remove your fingers, then separate the pictures slightly and move them

toward each other until they fuse. Continue this practice with other pairs of photographs until you have acquired the knack of putting them under the stereoscope and fusing them rapidly. By this stage you should be ready to begin using the stereoscope as an important, time-saving item of equipment in your day by day activities.

When viewing some aerial photos, especially if they are enlargements of the original 9x9 inch size, it is frequently necessary, when attempting to get identical images close enough together under the stereoscope, to lift or roll upward the inside edge of the top photo.

PERSONAL TRICKS AND PROCEDURES

As you gain increased proficiency in using the stereoscope as a working tool, you will discover for yourself many details and tricks of procedure. For example, you will learn that good light is essential, and that photographs need to be equally illuminated, and without glare. Shadows on the photos should extend toward you and away from the illuminating light, providing the light is behind the stereoscope where it should be. Shadows extending away from you may cause inversion of the stereoscopic image (ridges appear as valleys).

You will discover the central part of the photograph is least distorted, and that distortion increases with distance from the center due to the inherent nature of photography. Except in areas of strong relief this distortion need not bother you. You will find it necessary to keep the stereoscope directly over the object or area being examined. Never attempt interpretation at an oblique angle as this will involve distortion.

You will find, that due to differences in angles of reflected light, the tone of an object may be strikingly different on two successive photographs. Thus, in one photograph, with the light rays reflected from a water surface toward the camera, the body of water will appear light, while in an adjoining photograph, with the angle of reflection away from the camera, the same water surface appears dark. Ground cover may absorb light and photograph gray or dark gray, or it may reflect light and photograph light gray to white. Most natural features, however, reflect light in all directions and appear in intermediate tones. In interpreting the detail seen in your photographs, you also will attach importance to the shape of the features as well as to these differences in tone.

You will find it extremely helpful to study your aerial photographs with a stereoscope before going into the field. You can make provisional interpretations of features and familiarize yourself with the general as well as the detailed conditions. Trails and obscure paths can be marked for reference, as well as possible places where streams can be crossed. Buildings which might otherwise be overlooked can be marked for later checking in the field. You will tentatively outline many features such as areas of equal slope, gullies, eroded areas, pasture or idle land, and forests, and thereby conserve your field time.

You will find it essential in the beginning to check the accuracy of all stereoscopic interpretations through systematic observations in the field. You will discover that all delineations and symbols should be put on your photographs in pencil, and inked only after confirmation in the field.

And you will learn that the accuracy of your photo interpretation of land conditions is very greatly dependent upon your own familiarity with local conditions. You will recognize that your ability to interpret photographs accurately in one area will not necessarily be an assurance of equal accuracy in another area having conditions with which you are unfamiliar.

When you have achieved a notable proficiency in the use of a stereoscope, you will join others in insisting that this approach not only speeds up the survey job, but substantially increases its accuracy and quality. With this conviction and a high degree of familiarity with your area, you will find yourself identifying quite narrow distinctions in many of the features, such as: differences in soil texture and depth; critical areas of slope or erosion; direction and gradient of slope; different degrees of wetness; fence lines; irrigation and drainage systems; watershed boundaries; and woodland or range vegetation.

VALUE OF VERTICAL EXAGGERATION

From the land forms and general surface configuration, you should be able to identify many physical features and conditions under the stereoscope which will save you a great deal of time and effort in actual field examination. The exaggerated vertical dimension, so characteristic of most stereoscopic images, is an asset in recognizing these forms, even though at first you might find it

disturbing to your sense of realism. This exaggeration will help you in several ways, including the following:

Many characteristics of the soil may be interpreted through their associations with specific land forms. Once you are familiar with an area you can predict with considerable confidence the kind of soil on the alluvial fan as distinguished from that on the terrace, or that in hilly areas from that on the stream bottoms. The boundaries or limits of the land forms are evident under a stereoscope and can be accurately located.

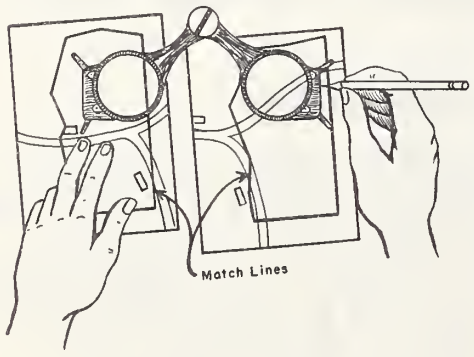
Slope separations are definitely related to configuration of the land, and can be delineated more accurately and rapidly with a stereoscope. The stereoscopic approach is of particular advantage in areas covered by thick brush and timber.

All forms of erosion can be mapped more satisfactorily because of this stereoscopic exaggeration. Gully erosion, dunes, blowouts and stream bank erosion are the easiest to see. Sheet erosion is seen by noting tone changes on ridgetops, knobs and some slopes.

Drainage patterns are also more easily and quickly recognized and mapped. Their relative importance, the watershed area they traverse, and other related details can be determined.

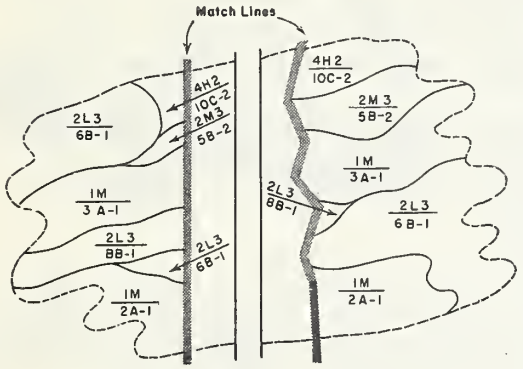
MATCH LINES AND MATCHING

A match line is a line drawn arbitrarily in the overlap area of one photograph, to serve as a boundary for the mapping on that photograph, matched by a similar line drawn through identical points on the adjoining photograph.



In placing match lines on photographs stereoscopically, a straight line is drawn about midway through the overlap area on one photograph. This photograph and its adjoining mate are then placed under the stereoscope, the images fused and the drawn straight line is transferred to the adjoining picture. This line should be transferred by marking its location on all high points or

ridges and on all low points or drainage and then connecting these points with a series of straight lines across the photograph. This procedure is particularly desirable in areas of very rough or mountainous terrain. It is advisable to draw match lines in pencil (preferably green) and not use ink.



Boundaries of all mapping units and other features should be broken sharply at match lines, especially when inked. Matching of mapping detail on one photograph with that on another can best be done stereoscopically. The mapped photograph and the adjoining unmapped one are placed under the stereoscope and the images fused. Features mapped along the match line of the completed photograph can then be transferred to the adjoining photograph. In the case of mapping units which are split by a match line, the symbol should be placed <u>horizontally</u> on the larger portion, <u>within</u> a match line. The symbol for the portion on the other photograph, if it is of small extent, should be placed on a <u>45° angle</u>, outside the match line.

HELPFUL IDEAS AND DEVICES

The more capable you are in the stereoscopic approach, the more demanding and ingenious you will become. You will have new ideas and will devise improvements in equipment. Many of these developments will be of interest to others, especially to those not so experienced in this technique. Send in your improvement suggestions; we will endeavor to convey them to all concerned. Some have already been received and these are presented in the following paragraphs.

<u>Training aids</u>, which have been helpful in presenting the stereoscopic approach to inexperienced people, include such items as:

A stereo-projector, aluminum screen and series of selected slides. This combination is particularly valuable in focusing the attention of a small group (6-12 people) on a single stereoscopic feature. As polaroid filters and spectacles are involved, both black and white and colored slides can be projected. Generally there is a minor loss in sharpness of detail due to magnification in this projection. For the same

Generally there is a minor loss in sharpness of detail due to magnification in this projection. For the same reason, greater precision is essential in positioning the two pictures on the slide.

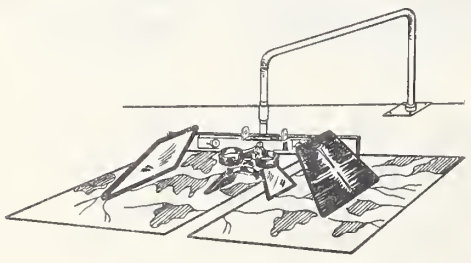
A box-type stereo-viewer and selected slides. This combination is best suited for use with individuals and excellent results are secured when the slide is illuminated by battery light. The definition of features is very sharp, and because there is no enlargement, positioning of pictures on the slide may be less precise.

Stereoscopes of both mirror and lens types. The first is best suited for office use; the second, or folding type, is better suited for use in the field.

Stereo-pairs of selected aerial photographs. Through common usage, we are most familiar with black and white, vertical pictures. However, these pairs might also be color photographs or oblique landscapes. Contact prints have the sharpest detail, but enlargements up to a scale of eight inches to the mile may be used.

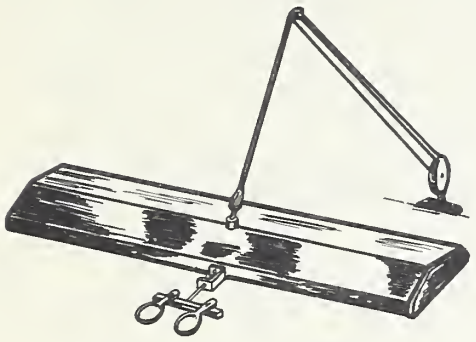
Side by side prints of selected stereo-pairs. These, like those which accompany this training guide, are printed with the two pictures in proper stereoscopic position relative to one another. This eliminates the difficulty involved in orienting separate prints. In special instances, two other types of prints, might also be helpful. These are "vectographs," or two polaroid pictures overprinted in a single frame; and "anaglyph," or overprinted two-color pictures. Both need to be viewed through the proper spectacles, however.

Devices suggested for office use are numerous, and so far, include methods for supporting the stereoscope, for handling large photographs, and for determining differences in ground elevation.



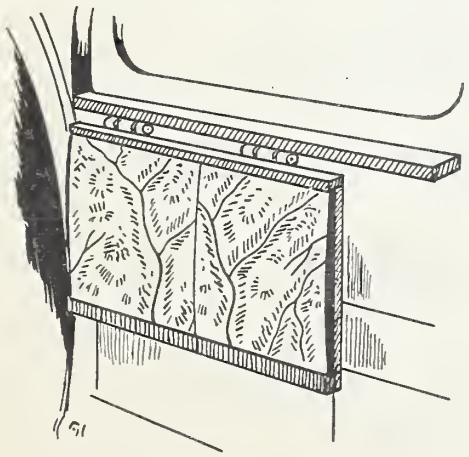
Several devices for supporting the stereoscope over the photographs have been proposed. One involves mounting a vertical rod at the rear of a desk or table, with a horizontal arm to support and swing the stereoscope over the work surface. Another attaches the stereoscope to the flexible standard of an ordinary gooseneck lamp. A third makes

use of an accordion-type telephone extension unit. This has a terminal support with easy-rolling caster at the stereoscope end.



A very handy method of mounting is to utilize a common type of drafting lamp by attaching a pair of simple stereoscope lenses to the lamp shade (as illustrated). In this manner the stereoscope may be moved about over the photographs by moving the lamp's adjustable supporting arm and the light is always in the proper position for excellent illumination of the photographs being studied.

Handling large photographs is sometimes difficult under the limited span of a stereoscope. In some instances this may be reduced by putting the photographs in correct position, and bending upward the excessive overlap. Or this same result can be achieved by having a slot in the table top, or supporting base, through which the excess parts of the photographs are bent downward. You can improvise this slot arrangement by putting two tables end to end.



Devices for field use include a drop shelf, which has been designed for attachment inside the right-hand door of a pickup. For use, the surveyor raises this shelf with its one-inch central slot, puts his photographs in position, and studies them with his field stereoscope. Among the advantages are: Effective use of stereoscope out in the field; the drop-leaf arrangement permits the shelf to be raised or lowered easily; the car door can be opened or closed at any time; door handle and window crank are always accessible; aerial photographs can be carried in place, with shelf either up or down; and the whole unit can be installed or removed without marring any part of the vehicle.

A device for determining elevations. The Abrams Height Finder, Model, HF-2, is adapted for use with field type lens stereoscopes. Differences in elevation are readily determined. This attachment is small, the cost is not excessive, and it appears to have a wide range of uses by soils men, engineers, farm planners and other technicians. So far, it has been used in a preliminary way to determine differences in elevation between one end of a field and another, at locations where a reservoir is to be constructed, and to determine the lift from pump to reservoir. This device is not suitable if there is tilt in the photos.

BOOKS ON STEREOSCOPY

Volumes have been written about the use of stereoscopes by various authorities in this field. The following list offers six of these for your attention:

Aerial Photographs: Their Use and Interpretation, A. J. Eardley

Interpretation of Aerial Photographs, TM 5-246, Issued by the War Department, December 31, 1942

Origin, Distribution and Airphoto Identification of U. S. Soils, D. S. Jenkins, U. S. Department of Commerce

Manual of Photogrammetry, American Society of Photogrammetry

Engineering Applications of Aerial and Terrestrial Photogrammetry, B. B. Talley

Aerial Photographs in Forestry, Stephen H. Spurr